

# Meal-Specific Dietary Changes From *Squires Quest! II*: A Serious Video Game Intervention

Karen W. Cullen, DrPH, RD; Yan Liu, MS; Debbe I. Thompson, PhD

## ABSTRACT

**Objective:** *Squire's Quest! II: Saving the Kingdom of Fivealot*, an online video game, promotes fruit and vegetable (FV) consumption. An evaluation study varied the type of implementation intentions used during the goal-setting process (none, action, coping, or both action and coping plans). Participants who created action plans reported higher FV consumption 6 months after baseline. This study assessed changes by specific meal in that study.

**Methods:** A total of 400 fourth- and fifth-grade children completed 3 24-hour recalls at baseline and 6 months later. These were averaged to obtain FV intake. Analyses used repeated-measures ANCOVA.

**Results:** There was a significant group by time effect for vegetables at 6 months ( $P = .01$ ); Action ( $P = .01$ ) and coping ( $P = .04$ ) group participants reported higher vegetable intake at dinner. There were significant increases in fruit intake at breakfast ( $P = .009$ ), lunch ( $P = .01$ ), and snack ( $P < .001$ ).

**Conclusions and Implications:** Setting meal-specific goals and action or coping plans may enable children to overcome barriers and consume FV.

**Key Words:** video game, fruit, vegetables, children, implementation intentions (*J Nutr Educ Behav.* 2016;48:326-330.)

Accepted February 10, 2016.

## INTRODUCTION

Few children in the US consume the daily recommended amounts of fruits (F) and vegetables (V) (FV)<sup>1</sup>: at least 1.5 cups of F and 2.0–2.5 cups of V.<sup>2</sup> Fruits and vegetables are low in energy density and high in fiber, and may reduce the risk for developing chronic diseases such as cardiovascular disease and certain cancers.<sup>3,4</sup> Interventions to establish behaviors in childhood are important so that they may track into adulthood.<sup>5,6-8</sup> However, not all interventions to improve FV intake among children have been successful.<sup>9-11</sup>

Serious video games are designed to both entertain and promote behavior change.<sup>12-14</sup> One serious video game intervention, *Squire's Quest!*

(SQ!), successfully improved total FV intake among children,<sup>15</sup> with significant improvements for F and 100% F juice consumption at snacks and for regular V at lunch.<sup>16</sup> The SQ! intervention sessions included setting meal-specific goals for eating FV, and suggested that goal setting was an important component. However, there was only a weak association among goal setting, goal attainment, and FV consumption.<sup>17</sup>

Implementation intentions are detailed plans connected to achieving a specific goal.<sup>18,19</sup> Action plans identify the specifics of how (ie, what, when, where) the goal will be attained. To create coping plans, children identify common barriers that could interfere with meeting a goal and then identify ways to overcome them.<sup>18,19</sup>

In *Squire's Quest! II, Saving the Kingdom of Fivealot* (SQ!II), an updated and enhanced version of the original SQ! intervention, implementation intentions were added to the goal-setting procedure.<sup>18</sup> It was hypothesized that creating either action or coping plans would improve children's ability to achieve their goals, and that creating both plans would add assistance to children to attain their goals and maintain them over a longer period.

In each game episode, the children set goals.<sup>20,21</sup> In 5 episodes, children set specific F or V goals for a specific meal: 1 breakfast, 1 lunch, 1 dinner, and 2 snacks. Children could select the meal for 1 F and 1 V goal in 2 episodes. In the last 3 episodes, the children were to set a personal FV schema for eating 5 FV servings daily, such as 1 F for breakfast, 1 F and 1 V for lunch, 1 F for snack, and 1 V for dinner.

A recent randomized control trial that evaluated SQ!II with fourth- and fifth-grade children and assessed intake at baseline and about 3 and 6 months afterward documented success.<sup>21</sup> Fruit and vegetable intake was significantly higher at 3 months for the action and coping groups compared with baseline.<sup>21</sup> Only the action group children maintained

US Department of Agriculture/Agricultural Research Center, Children's Nutrition Research Center, Baylor College of Medicine, Houston, TX

**Conflict of Interest Disclosure:** The authors' conflict of interest disclosures can be found online with this article on [www.jneb.org](http://www.jneb.org).

Address for correspondence: Karen W. Cullen, DrPH, RD, USDA/ARS Children's Nutrition Research Center, Baylor College of Medicine, 1100 Bates St, Houston, TX 77030; Phone: (713) 798-6764; Fax: (713) 798-9068; E-mail: [kcullen@bcm.edu](mailto:kcullen@bcm.edu)

©2016 Society for Nutrition Education and Behavior. Published by Elsevier, Inc. All rights reserved.

<http://dx.doi.org/10.1016/j.jneb.2016.02.004>

the increase at 6 months. Regardless of the group, there were significantly higher F intakes at both 3 and 6 months compared with baseline.

Because the children completed 24-hour dietary recalls, meal-specific changes could be identified. The objective of this report was to assess whether there were significant meal-specific changes 6 months after baseline for children participating in this intervention.

## METHODS

### Study Design

The primary study methods and outcomes have been described elsewhere but are briefly summarized here.<sup>20,21</sup> The outcome evaluation study was a randomized design with 4 groups; the groups were based on the type of implementation intentions used within the goal-setting component in each episode (none, action, coping, and action plus coping). All groups played the same 10-episode online video game and set a goal to eat an FV in each episode. Data were collected at baseline and at about 3 and 6 months after baseline; only data from baseline and 6 months were analyzed in this study. Children were to attain the FV goal before playing the next episode and record goal attainment in the game.

Parents were e-mailed a newsletter for each episode and a link to a parent Web site. The content included information on their child's weekly goals, suggestions for supporting achievement of FV goals, and ways to overcome common barriers to helping their family make healthy food choices.

### Sample

Participants were 400 children in the fourth or fifth grade (approximately 9- to 11-year-olds) who spoke English and had a computer and high-speed Internet access. Standard recruitment methods were used, such as flyers distributed to schools and community groups and postings on volunteer Web pages.<sup>18</sup> The study was powered to detect a small effect size (Cohen's  $d = 0.17$ ) of at least at least 0.51 servings<sup>20,21</sup> in a child's FV intake. This study was approved by the Institutional Review Board at Baylor

College of Medicine, Houston, TX. The researchers obtained written parental consent and child assent.

### Measurement

At each data collection period, the children completed 3 unannounced 24-hour dietary recalls (2 weekday and 1 weekend day) conducted via phone by trained staff using Nutrition Data System for Research–2009 (Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN).<sup>22</sup> As in the primary study, servings of F, but not 100% F juice, and regular V, not high-fat V, were calculated using Nutrient Data System for Research output. Fruit and V intake from each 3-day period were averaged to improve dietary intake estimates. Breakfast, lunch, snack, and dinner intakes were calculated.

### Statistical Analysis

Baseline demographic characteristics and FV intake were examined to identify group differences using chi-square analysis and ANOVA for categorical and continuous variables, respectively. Numerical (skewness, kurtosis, and Kolmogorov–Smirnov D) and graphical methods were used for data normality testing. Because the dietary data were skewed (some children consumed no food for some food groups), all selected outcomes variables were log-transformed for analyses. The adjusted means presented in the tables were back-transformed to the original scale. Intervention group, time, and group by time interactions were included in the models.

To evaluate meal-specific changes from baseline to 6 months, a repeated-measures mixed-effects model<sup>23</sup> with a 4-level between-subject factor (group: control, action, coping, and action plus coping) and a 2-level within-subject factor (time: baseline and 6 months) was used. Subjects were treated as random effects, and group, measurement time (baseline and 6 months), and group by time interactions as fixed effects. Restricted maximum likelihood and weighted least-squares estimated variance components and fixed effects, respectively. All mixed-effects models were adjusted for child gender, race/ethnicity, total energy intake, parent

age, and household education. *Post hoc* analyses were conducted for each meal occasion. All statistical analyses were conducted with Statistical Analysis Software (version 9.3, SAS Institute Inc., Cary, NC, 2012). Significance was set at  $P < .05$ .

## RESULTS

### Baseline Characteristics

Participating children were diverse (white, 36.8%; Hispanic, 27.4%; African American, 26.4%); 52.7% were female. Most parents were female (96.3%), married (77.5%), and aged 40–59 years (55.3%), with an average household income of  $> \$61,000$  (57.6%). A total of 387 children had complete data. There were no group differences in baseline demographic characteristics or FV intake.

### Fruit and Vegetable Intake

At baseline, children consumed a daily average of 0.63 servings of F and 1.13 servings of V regardless of group.<sup>21</sup> There was a significant intervention group by time interaction effect for V ( $P = .01$ ); the relationship for V intake between the 2 time points differed based on group. Action ( $P = .01$ ) and coping ( $P = .05$ ) group participants reported higher V intake at dinner at 6 months than at baseline (Table). In the overall models, there were significant increases over time for F intake at breakfast ( $P = .009$ ), lunch ( $P = .014$ ), and snack ( $P < .001$ ) at 6 months.

## DISCUSSION

This study examined longitudinal changes in FV intake by specific meal after children played a 10-episode serious video game that systematically varied implementation intentions during goal setting. In the primary study, the only significant intervention interaction effect at 6 months was a 0.68-serving increase in total FV intake for the action group.<sup>21</sup> However, there were overall significant time effects for F intake alone.<sup>21</sup> In this current analysis of meal-specific changes, there were significant increases of 32% (1.5 tablespoons) and 18% (1.2 tablespoons) in dinner V intake for the action and coping

**Table.** Adjusted Means (SE) for Servings of Fruits and Vegetables Across Meals, Groups, and Time for 387 Fourth- and Fifth-Grade Children Participating in *Squire's Quest! II* Video Game Intervention

Meal	Control (n = 97)		Action (n = 98)		Coping (n = 95)		Action Plus Coping (n = 97)	
	Baseline	6 Mo	Baseline	6 Mo	Baseline	6 Mo	Baseline	6 Mo
Breakfast								
Fruit <sup>a, **</sup>	0.14 (0.02)	0.16 (0.02)	0.09 (0.02)	0.17 (0.02)	0.09 (0.02)	0.14 (0.03)	0.10 (0.02)	0.10 (0.03)
Lunch								
Fruit <sup>a, *</sup>	0.25 (0.02)	0.27 (0.03)	0.21 (0.02)	0.30 (0.03)	0.23 (0.03)	0.31 (0.03)	0.31 (0.03)	0.32 (0.03)
Vegetables	0.41 (0.03)	0.44 (0.03)	0.42 (0.03)	0.50 (0.03)	0.41 (0.03)	0.41 (0.03)	0.47 (0.03)	0.45 (0.03)
Snack								
Fruit <sup>a, ***</sup>	0.19 (0.03)	0.25 (0.04)	0.14 (0.03)	0.33 (0.04)	0.20 (0.03)	0.31 (0.04)	0.19 (0.03)	0.32 (0.04)
Vegetables	0.05 (0.01)	0.03 (0.02)	0.04 (0.01)	0.09 (0.02)	0.04 (0.01)	0.08 (0.02)	0.04 (0.01)	0.08 (0.02)
Dinner								
Fruit	0.11 (0.02)	0.08 (0.02)	0.08 (0.02)	0.09 (0.02)	0.07 (0.02)	0.10 (0.02)	0.10 (0.02)	0.09 (0.02)
Vegetables <sup>b, *</sup>	0.62 (0.03)	0.73 (0.04)	0.59 (0.03)	0.78 (0.04)	0.67 (0.03)	0.82 (0.04)	0.83 (0.03)	0.71 (0.04)

\* $P < .05$ ; \*\* $P < .01$ ; \*\*\* $P < .001$ ; <sup>a</sup>Significant time effect; <sup>b</sup>Significant group  $\times$  time effect–overall; within groups, action and coping groups had a significant increase in vegetable intake for dinner at 6 months.

Notes: The intervention included goal setting. Groups varied on whether and/or which implementation intentions were set during the goal-setting process (none, action plans, coping plans, or both action and coping plans).

groups, respectively. For F, the significant time increases represent approximately 0.66 tablespoons of F at both breakfast and lunch, and approximately 1.5 tablespoons at snack for the action group and about 0.35 tablespoons at breakfast, about 0.66 tablespoons at lunch, and approximately 1 tablespoon at snack for the coping group. Although these increases are small, overall meal improvements add up to increases in daily FV that are similar to those in the literature, which range from 0.25 to 0.99 servings.<sup>9,24,25</sup> The researchers found no studies that reported meal-specific FV outcomes for adults.

In the original SQ! program, there was a significant improvement in lunch V intake and in F and 100% fruit juice intake at snacks for the intervention group.<sup>16</sup> In the current study, there were significant improvements in F intake alone at breakfast, lunch, and snacks over time, and the significant increase for V occurred at dinner. The impact for F intake at 3 meals could reflect the higher preference that children have for F compared with V,<sup>26,27</sup> which made it easier to improve F selection and consumption. The action plans the participants created were to identify strategies to help them be successful in meeting their goal, whereas the coping plans identified potential barriers and ways to overcome those barriers.

The number of V goals and either the action or coping plans the children created might have enabled participants to achieve their V goal for dinner. Whether the children used the plans to attain their goals was not evaluated. A few school-based studies assessed meal-specific FV changes. After a 5-A-Day program, school lunch observation data revealed a significant increase in total F consumption among fourth- and fifth-grade students from 0.44 to 0.74 servings.<sup>28</sup>

A cafeteria-environment intervention resulted in a significant increase in F (no juice) consumption at lunch, based on student meal observations.<sup>27</sup> A UK school-based intervention observed or weighed student lunches in the cafeteria and documented significant improvements in FV intake for school-provided lunches and snacks<sup>29-31</sup> and in lunches from home.<sup>30</sup> A replication study in the US, using digital photography to assess consumption, documented significant increases in lunch FV intake.<sup>32</sup> None of the previous studies had specific meal and food item goals in the intervention, which made it difficult to compare them with the current study results.

The significant meal changes in this study also reflect the video game content, which focused on setting goals to eat FV at specific meals and snacks, and the addition of imple-

mentation intentions to the goal-setting component.<sup>20</sup> Participants attained an average of 8.7 out of 9 possible FV goals, and 79% of the children reported meeting all 9 FV game goals.<sup>33</sup> There were no differences in the number of goals achieved by group. There were 2 weekly goals for eating a V at both lunch and at dinner, 2 weekly goals for eating an F serving at both snack and breakfast, and 1 for eating an F at dinner.<sup>20</sup> In the last 3 episodes, children chose a schema during goal setting and then set a goal to eat the FV in the day's meals guided by that schema. The video game characters presented their personal schemas as examples.

Another possible explanation for success is the enhanced parent component in the current SQ!II program: a parent Web site and weekly newsletter e-mails to parents.<sup>20</sup> About 60% of parents reported visiting the Web site  $\geq 6$  times; about 60% reported reading  $\geq 4$  newsletters.<sup>21</sup> The materials could have helped parents support their children's goal attainment. The appropriate dose of an intervention to enable parents to support child dietary behavior change is unknown. Although parents received 5 newsletters sent home with their child in the previous intervention,<sup>15</sup> no data were reported on whether the parents read the newsletter.<sup>15</sup>

The group creating both action and coping plans was not successful in improving FV intake. It may be that the cognitive burden needed to create both types of plans for each goal was too great, especially during an interactive video game. This burden might have resulted in poorly devised plans that did not help children meet their goals, or it may be that the children simply did not make any plans. This study was not designed to capture the failure of combining the 2 plans.

The strengths of this research include a large multiethnic sample, high participation by children (91% played all 10 episodes), low attrition, an intervention developed with children and pilot-tested, the ability of the video game to deliver the intervention as designed, and the long 6-month evaluation period. The goals were specific, proximal, and realistic, which made them more likely to be achieved.<sup>34</sup>

Weaknesses include no group that did not set a goal; the age of the children, which may have influenced the accuracy of the dietary recalls; the relatively high income and education of the participating families; and that the study was conducted in only 1 geographic region, limiting generalizability.

## IMPLICATIONS FOR RESEARCH AND PRACTICE

In this study, a serious video game for children that included creating action and coping plans during the goal-setting procedure was an effective method for increasing meal-specific V intake at dinner 6 months after the intervention, and F intake at breakfast, lunch, and snacks for all intervention groups. Qualitative interviews are needed to investigate how children create and use action and coping plans in goal setting, and to understand why the group that was asked to set both action and coping plans was not successful. In addition, further research is warranted to replicate the study findings.

## ACKNOWLEDGMENTS

This work is a publication of the US Department of Agriculture/Agricultural

Research Center (USDA/ARS), Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine, Houston, TX. This project was supported by the National Institutes of Health, National Institute of Child Health and Human Development Grant No. HD050595 (to Dr Thompson). This work is also a publication of the USDA/ARS, Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine, and was funded in part with federal funds from the USDA/ARS under Cooperative Agreement No. 58-6250-0-008. The contents of this publication do not necessarily reflect the views or policies of the USDA, nor does mention of trade names, commercial products, or organizations imply endorsement from the US Government.

## REFERENCES

1. Krebs-Smith SM, Guenther PM, Subar AF, et al. Americans do not meet federal dietary recommendations. *J Nutr*. 2010;140:1832-1838.
2. US Department of Agriculture. US Department of Health and Human Services. *Dietary Guidelines for Americans 2015–2020*. Washington, DC: US Government Publishing Office; 2015.
3. Bazzano LA. The high cost of not consuming fruits and vegetables. *J Am Diet Assoc*. 2006;106:1364-1368.
4. Boeing H, Bechthold A, Bub A, et al. Critical review: vegetables and fruit in the prevention of chronic diseases. *Eur J Nutr*. 2012;51:637-663.
5. Kudlova E, Schneidrova D. Dietary patterns and their changes in early childhood. *Cent Eur J Public Health*. 2012;20:126-134.
6. Mikkila V, Rasanen L, Raitakari OT, et al. Consistent dietary patterns identified from childhood to adulthood: the Cardiovascular Risk in Young Finns Study. *Br J Nutr*. 2005;93:923-931.
7. Lien N, Lytle LA, Klepp KI. Stability in consumption of fruit, vegetables, and sugary foods in a cohort from age 14 to age 21. *Prev Med*. 2001;33:217-226.
8. te Velde SJ, Twisk JW, Brug J. Tracking of fruit and vegetable consumption from adolescence into adulthood and its longitudinal association with overweight. *Br J Nutr*. 2007;98:431-438.
9. Knai C, Pomerleau J, Lock K, et al. Getting children to eat more fruit and vegetables: a systematic review. *Prev Med*. 2006;42:85-95.
10. Evans A, Ranjit N, Rutledge R, et al. Exposure to multiple components of a garden-based intervention for middle school students increases fruit and vegetable consumption. *Health Promot Pract*. 2012;13:608-616.
11. Bourke M, Whittaker PJ, Verma A. Are dietary interventions effective at increasing fruit and vegetable consumption among overweight children? A systematic review. *J Epidemiol Commun Health*. 2014;68:485-490.
12. Thompson D, Baranowski T, Buday R, et al. In pursuit of change: youth response to intensive goal setting embedded in a serious videogame. *J Diabetes Sci Technol*. 2007;1:907-917.
13. Thompson D, Baranowski T, Buday R, et al. Serious video games for health: how behavioral science guided the development of a serious video game. *Simul Gaming*. 2010;41:587-606.
14. Thompson D. What serious video games can offer child obesity prevention. *JMIR Serious Games*. 2014;2:e8.
15. Baranowski T, Baranowski J, Cullen KW, et al. Squire's Quest! Dietary outcome evaluation of a multimedia game. *Am J Prev Med*. 2003;24:52-61.
16. Cullen KW, Watson K, Baranowski T, et al. Squire's Quest: Intervention changes occurred at lunch and snack meals. *Appetite*. 2005;45:148-151.
17. Cullen KW, Zakeri I, Pryor EW, et al. Goal setting is differentially related to change in fruit, juice, and vegetable consumption among fourth-grade children. *Health Educ Behav*. 2004;31:258-269.
18. Gollwitzer PM. Implementation intentions: strong effects of simple plans. *Am Psychol*. 1999;54:493-503.
19. Gollwitzer PM, Sheeran P. Implementation intentions and goal achievement: a meta-analysis of effects and processes. *Adv Exp Soc Psychol*. 2006;38:69-119.
20. Thompson D, Bhatt R, Lazarus M, et al. A serious video game to increase fruit and vegetable consumption among elementary aged youth (Squire's Quest! II): rationale, design, and methods. *JMIR Res Protoc*. 2012;1:e19.
21. Thompson D, Bhatt R, Vazquez I, et al. Creating action plans in a serious video game increases and maintains child



- fruit-vegetable intake: a randomized controlled trial [published online ahead of print March 18, 2015]. *Int J Behav Nutr Phys Act*. doi:10.1186/s12966-015-0199-z.
22. Lytle LA, Murray DM, Perry CL, et al. Validating fourth-grade students' self-report of dietary intake: results from the 5 A Day Power Plus program. *J Am Diet Assoc*. 1998;98:570-572.
  23. Twisk J, de Boer M, de Vente W, et al. Multiple imputation of missing values was not necessary before performing a longitudinal mixed-model analysis. *J Clin Epidemiol*. 2013;66:1022-1028.
  24. Thomson CA, Ravia J. A systematic review of behavioral interventions to promote intake of fruit and vegetables. *J Am Diet Assoc*. 2011;111:1523-1535.
  25. Evans CE, Christian MS, Cleghorn CL, et al. Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 y. *Am J Clin Nutr*. 2012;96:889-901.
  26. Domel SB, Baranowski T, Davis H, et al. Measuring fruit and vegetable preferences among 4th- and 5th-grade students. *Prev Med*. 1993;22:866-879.
  27. Perry CL, Bishop DB, Taylor GL, et al. A randomized school trial of environmental strategies to encourage fruit and vegetable consumption among children. *Health Educ Behav*. 2004;31:65-76.
  28. Perry CL, Bishop DB, Taylor G, et al. Changing fruit and vegetable consumption among children: the 5-A-Day Power Plus Program in St. Paul, Minnesota. *Am J Public Health*. 1998;88:603-609.
  29. Horne PJ, Tapper K, Lowe CF, et al. Increasing children's fruit and vegetable consumption: a peer-modelling and rewards-based intervention. *Eur J Clin Nutr*. 2004;58:1649-1660.
  30. Horne PJ, Hardman CA, Lowe CF, et al. Increasing parental provision and children's consumption of lunchbox fruit and vegetables in Ireland: the Food Dudes intervention. *Eur J Clin Nutr*. 2009;63:613-618.
  31. Upton D, Upton P, Taylor C. Increasing children's lunchtime consumption of fruit and vegetables: an evaluation of the Food Dudes programme. *Public Health Nutr*. 2013;16:1066-1072.
  32. Wengreen HJ, Madden GJ, Aguilar SS, et al. Incentivizing children's fruit and vegetable consumption: results of a United States pilot study of the Food Dudes Program. *J Nutr Educ Behav*. 2013;45:54-59.
  33. Thompson D, Cullen KW, Liu Y, et al. Effect of goal attainment on fruit and vegetable consumption in a serious videogame. [In preparation]. 2016.
  34. Locke EA, Shaw KN, Saari LM, et al. Goal setting and task performance: 1969-1980. *Psychol Bull*. 1981;90:125-152.

## Sign Up for JNEB's Alerts

The *Journal of Nutrition Education and Behavior* (JNEB) offers 3 alerts to your in-box. Sign up to receive notification of

- Free access to Tables of Contents and all article abstracts
- Free access to select full text articles
- Free e-alerts and search personalization

To register for alerts, go to

<http://www.jneb.org/user/alerts>

### **CONFLICT OF INTEREST**

The authors have not stated any conflicts of interest.